USER'S MANUAL

MODEL: 231HC Bipolar Current Amplifier

WARNING

The output from the Model 231HC is potentially lethal. Do not operate without protective covers and an inspection by an authorized person.

PROPRIETARY

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GMW

955 Industrial Road, San Carlos, CA 94070 Tel: (650)802-8292 Fax: (650) 802-8298
E-mail: sales@gmw.com Web: http://www.gmw.com

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Section 1

WARNINGS

REFER TO WARNINGS BELOW BEFORE OPERATING THE 231HC AMPLIFIER

2.1 - Personal Safety

Never service alone. Do not perform service to the 231HC and associated DC Power Supply unless another person is present who is capable of rendering first aid.

The output from the model 231HC is potentially lethal. It is capable of delivering high voltages at high current. Do not remove protective covers or leave cable terminations exposed. Do not operate the amplifier if terminals or cables are damaged.

The 231HC Amplifier incorporates a capacitor bank of 0.2F capacitance to provide high peak power. This capacitor bank and other internal components will remain charged for several minutes even after the DC Power Supply is switched off.

Always disconnect the input dc power before servicing and ensure that sufficient time has passed to completely discharge the capacitor bank before servicing the DC Power Supply, 231HC Amplifier or its connected load. Always assume the presence of hazardous voltages. Always connect a short insulated jumper cable across the dc input terminals before removing any protective covers. Refer to Drawing 13907-0002-1.

2.2 - Current Connections

Special care should be taken to insure that the current terminations are secure and do not work loose in operation. Local heating at the terminations can cause rapid oxidation leading to a high contact resistance and high power dissipation at the terminals. If left unchecked this can cause enough local heating to damage the current connection terminals.

2.3 - Interlocks

The 231HC Amplifier has interlock connections between the DC Power Supply and the Electromagnet load. The interlocks must be connected for proper system functioning and protection of the equipment, facility and to protect against personal injury. Attempting to operate the system with the interlocks defeated is not recommended.

Section 2

SPECIFICATIONS

Table 1. Model 231HC Bipolar Current Amplifier Specifications

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Electrical

Power Input (From DC Supply) 50V minimum to 160V maximum
Up to 1,000W required by the power amplifier

Recommended DC Power Supplies Sorensen SGA 160/31 160V, 31A, 4,960W
Sorensen SGA 160/63 160V, 63A, 10,080W

Power Input for DC Power Supplies

Voltage		187 - 242VAC*	342-440VAC	396 - 528VAC
Current	SGA 160/31	21A	14A	13A
	SGA 160/63	41A	27A	26A

3 phase, 3 wire plus ground
* Standard delivery

Input Capacitor Bank 200mF
20 x 10,000µF, 250VDC

Power Input (Aux Power Supply) 115VAC, 50/60Hz, 2A
or 220VAC, 50/60hz, 1A
User selectable on rear panel

Power Output 160V, 70A maximum
With SGA 160/31, approx. 3,960W average
With SGA 160/63, approx 9,080W average

Control Modes

Computer Control National Instruments Multifunction DAQ, Model USB-6251
Current Control Resolution: 16 bits(1)
Current & Voltage Monitor Resolution:16 bits
Digital read back of amplifier and magnet interlock status
Magnetic field read back resolution:16 bits

Output Current Control(1) Differential, ±10 volt analog input on rear panel
Input Impedance 50KΩ each input to ground, 25KΩ to each other

External Monitoring of Output Current & Voltage

Current Output: ±1V/10A, ±1%, Output Impedance 0.1Ω
Voltage Output: ±1V/20V, ±1%, Output Impedance 0.1Ω

Note (1): The Current output control may be via either the USB interface or the analog interface, but not both.

Mechanical

231HC Amplifier

Form Factor	8U rack mount fully enclosed chassis
Overall Dimensions	482mm (19”) wide x 354mm (14”) high x 614mm (24.2”) deep
Weight	47 kg (100 lbs)

231HC Amplifier & SGA Power Supply in Optima Rack

Overall Dimensions	560.5 (22”) wide x 1,058 (41.6”) high x 823 (32.4”) deep
Weight (with Sorensen SGA 160/31)	135kg (300lbs)
Weight (with Sorensen SGA 160/63)	141kg (314lbs)

Section 3

INSTALLATION

Caution: The 231HC Amplifier's mass is approximately 47 kg (100 lbs). In many cases, the Amplifier will be pre-installed by GMW into a 19" EIA equipment rack. If it is not, care should be taken during rack mounting to avoid personal injury or damage to the equipment.

3.1 - Unpacking Instructions and Damage Inspection

3.1.1 - Systems Shipped with a GMW Supplied Rack:

1. Remove all eight of the lag bolts located at the lower edge of all the side panels of the crate top cover.
2. Gently rock the crate top cover to work it loose from the shipping crate base.
3. Use one person on each side of the shipping crate grip the side panels of the crate top cover. Lift the crate top cover high enough to clear top of the rack, walk the cover sideways to a clear area and place it upon the floor.
4. Inspect the rack and its contents to ensure that no damage has occurred during shipment. If any damage is evident report the damage in detail to the shipper for claim and simultaneously notify GMW in case an assessment of the damage must be made. If no damage is found, proceed with the unpacking and installation.
5. Cut the straps that secure the rack to the pallet base.
6. Remove the wood block at the bottom front edge of the rack.
7. Carefully slide the rack forward and off of the pallet base.
8. Unpack any other system components as per their instruction manuals.

3.1.2 - Systems Shipped without a GMW Supplied Rack:

1. Open the shipping crate by removing the spring clips along the crate top panel.
2. Cut the straps that secure the amplifier into the shipping crate.
3. Using two people, carefully lift the amplifier clear of the shipping crate. Handles have been provided on the front as well as the rear of the amplifier case for this. Always lift the amplifier by all four handles.
4. Inspect the amplifier to ensure that no damage has occurred during shipment. If any damage is evident report the damage in detail to the shipper for claim and simultaneously notify GMW in case assessment of the damage must be made. If no damage is found, proceed with the installation.
5. Unpack any other system components as per their instruction manuals.

3.2 - Rack Mounting

When rack mounting the 231HC Amplifier it is important to note that the vertical mounting flanges alone are not strong enough to support the weight of the amplifier, and support angles on each side, beneath the 231HC, must also be used. Failure to use adequate support angles will result in equipment damage.

Take care when selecting a rack that it has enough depth to completely house the Amplifier and DC Supply. The RC-351930 Bench Height Rack offered by GMW has an internal depth of 762mm. Typical installations would put the DC Supply at the bottom of the rack, with the Amplifier just above, thus keeping the center of gravity as low as possible in the rack. Other instrumentation may then be installed in to the upper sections of the rack.

Note: Telco style racks are NOT appropriate for the Amplifier and DC Supply.

3.3 - Electrical Connections

Even if the Amplifier was ordered as a complete system and assembled into a rack by GMW, it is still recommended to follow and verify the following section as connections may have loosened during shipment.

Refer to drawing 13907-0003-0, Rev. C for a detailed connection diagram.

3.3.1 - DC Supply and Electromagnet Connections

1. Connect the DC Supply to Amplifier Cable. Refer to drawing 16907-0030-0. This cable provides the DC power, ground and interlock signals between the DC Power Supply and the Amplifier. Ensure that ALL connections are tight, the polarity is correct and the interlock cable is properly connected.

   Warning: It is critical to ensure the correct polarity current connections between the DC Supply and the Amplifier to avoid damage to the capacitor bank which is polarity dependent.

2. Connect the Amplifier to Electromagnet Cable. Refer to drawing 16907-0031-0. This cable provides the current, grounding and interlock signals between the Amplifier and the Electromagnet. Again ensure that ALL connections are tight, the polarity is correct and the interlock cable is properly connected.

3.3.2 - Amplifier Auxiliary Power

Connect the 115Vac or 220Vac power cord to the Amplifier. - This provides the Amplifier with its required auxiliary power for the interlocks, computer interface, magnetic field sensor and cooling fans.

3.3.1 - DC Supply Main Power

This procedure should be carried out by a qualified electrician.

1. Connect the DC Supply to the AC Mains service via an appropriate three-phase AC power disconnect / breaker panel. The maximum input currents per phase are given in Section 1, Specifications.

2. Ensure that the Electromagnet, Amplifier and DC Power Supply grounds are connected. The DC Power Supply must be connected to the local service ground. Refer to drawing 13907-0003-0.

Section 4

SYSTEM DESCRIPTION

4.1 - System Description

A complete system would typically consist of an appropriate SGA series DC power supply, the GMW 231HC, a Senis magnetic field transducer, an electromagnet and finally an appropriate computer and software or an external analog programming signal.

The DC Supply provides the 160V, 31A (or 160V, 63A) dc power to the 231HC Amplifier and is buffered by the 231HC's internal 200mF capacitor bank. The capacitor bank provides current for short duration overloads of the DC Supply. The DC Supply is interlocked to the 231HC by means of a relay contact in the 231HC. The Supply's output is enabled on a closed contact, providing protection should the interlock cable be disconnected. Two conditions will cause the interlock relay to open, shutting down the DC Supply's output: Failure in the auxiliary power supply in the 231HC or a failure in the temperature or water flow interlocks on the electromagnet load.

The 231HC Bipolar Current Amplifier integrates a Copley 231HC Amplifier with a 200mF capacitor bank, a National Instruments USB-6251 Control with USB interface and an auxiliary power supply into a single 19" rack mounting chassis.

The auxiliary power supply provides power for the cooling fans, interlocks and interface. It also provides -12V and +12V (400mA each) on the rear panel for an optional external Senis magnetic field transducer for magnetic field measurement and closed-loop field control. It is important to note that if the auxiliary supply is not powered up, the DC Supply's output will be inhibited.

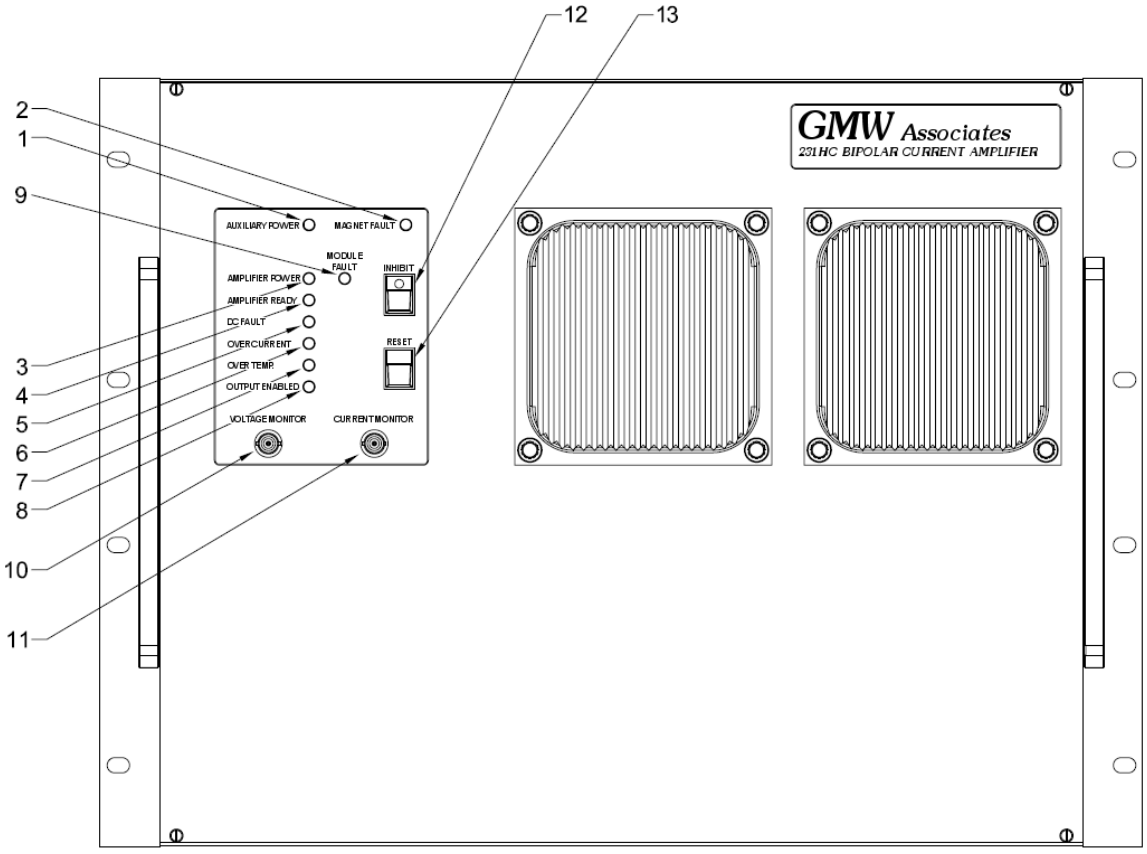
The interlock circuit for the magnet requires a 'closed contact' connection. Provision for both magnet over temperature and water flow is provided, but they are connected in series and simply 'Magnet Fault' is indicated on the status panel of the 231HC and when using the NI USB-6251 DAQ, this information is available via the computer control software. In the event of a magnet interlock fault, the output of the DC Supply is inhibited.

The NI USB-6251 DAQ interface provides computer control and monitoring of the system. It uses a 16-bit analog output (±10V) to provide the drive signal to the Copley Amplifier. The amplifier output voltage and current are monitored by two 16-bit input channels. Complete amplifier and magnet interlock status is also monitored via its digital input channels. When using an optional Senis magnetic field transducer, the field is read back on a third 16-bit analog channel. For more information, please refer to the NI USB-6251 Manual and section 4.5 in this manual.

The Copley 231HC Amplifier provides the power conversion from the fixed voltage DC Supply to a programmable current source for the electromagnet. The current output is proportional to the programming input of ±10V, supplied by either the NI USB-6251 or the external analog voltage input. The amplifier is set by GMW to a full scale range of ±70A output for ±10V input. For more information, please refer to the Copley Controls 231HC Manual.

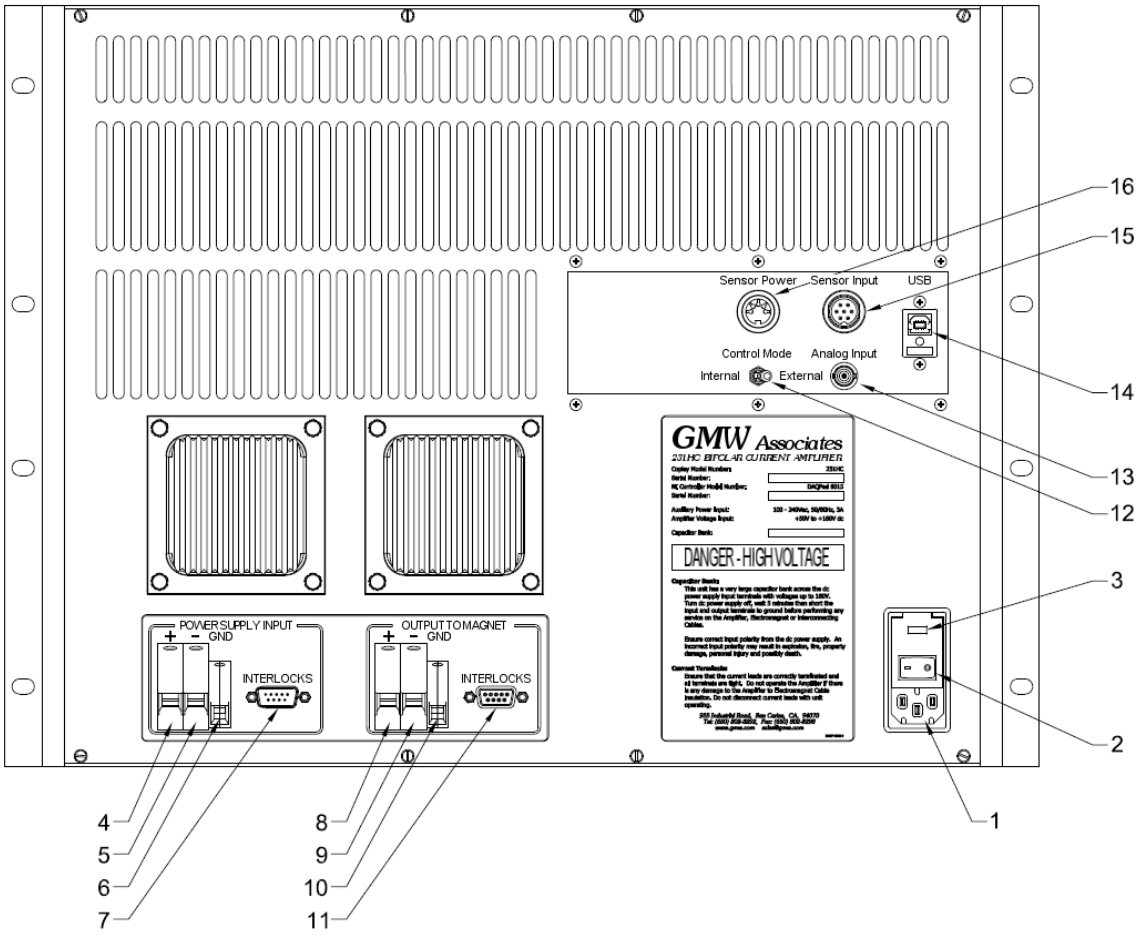
The optional Senis magnetic field transducer provides magnetic field monitoring for closed-loop control feedback. It is powered by the auxiliary power supply in the 231HC.

4.1.1 - Front Panel



1. Auxiliary Power - Indicates that auxiliary power is present
2. Magnet Interlock Fault - Indicates a fault with the magnet temperature or water flow interlocks
3. Amplifier Power - Indicates when DC power is provided to the 231HC
4. Amplifier Ready - Indicates either ‘Ready’ (Green) or ‘Fault’ (Red)
5. DC Fault - Indicates when DC power is outside the normal operating limits
6. Over Current - Indicates that the output is disabled due to over current over limits
7. Over Temperature - Indicates the 231HC is disabled due to an over temperature condition
8. Output Enabled - Illuminates when the 231HC output is enabled
9. Module Fault - Indicates the 231HC is disabled due to a fault in the amplifier’s MOSFET power output module
10. Voltage Monitor Output - ±1V / 20V, 1%
11. Current Monitor Output - ±1V / 10A, 1%
12. Output Inhibit Control - Inhibits the output of the 231HC
13. Reset Control - Resets fault conditions

4.1.2 - Rear Panel



1. AC Mains Input (Auxiliary Power Supply) - Either 115Vac, 2A or 220Vac, 1A
2. Power Switch - Enables the auxiliary power supply
3. Fuse Holder / Voltage Selector
4. Power Input '+' - DC power supply input POSITIVE connection (1)
5. Power Input '-' - DC power supply input NEGATIVE connection (1)
6. Ground - DC power supply GROUND connection
7. Power Supply Interlock - DC power supply interlock connection
8. Power Output '+' - Electromagnet power output POSITIVE connection
9. Power Output '-' - Electromagnet power output NEGATIVE connection
10. Ground - Electromagnet GROUND connection
11. Magnet interlock - Electromagnet interlock connection
12. Control Mode Switch - Selects either internal computer control or external analog control input signal.
13. Analog Input - When selected, the amplifier output current of ±70A is proportional to a ±10 volt control signal applied to this terminal
14. USB Port - USB connection for computer control
15. Sensor Input - Senis analog magnetic field transducer input
16. Sensor Power - ± 12V power for Senis magnetic field transducer

Note:

(1) The DC power input polarity must be correct. Reverse polarity will destroy the capacitor bank

4.2 - Initial Operational Testing

Once the 231HC system is connected it is time to perform initial system operational checks.

Start by switching on the auxiliary power supply in the 231HC. The switch is in the power entry module at the rear of the unit. At this point the 'Auxiliary Power' LED in the status panel should illuminate. The 'Magnet Fault' LED should be off, if it is not check that the magnet interlocks are correctly connected and functioning.

If a system complete with computer and software was purchased, the Amplifier Control and Monitoring software should be started now. Please refer to the software manual for configuration details.

The next step is to provide DC power the 231HC. Ensure that the voltage and current controls of the SGA DC Power Supply are set to the minimum output before turning on the main power to the DC Supply. Turn on the DC Supply and set the current output control to about 5% (about 3 turns clockwise). Next slowly bring up the Voltage control. At about 20 volts, the 'Amplifier Power', 'Amplifier Ready' (red aspect) and the 'DC Fault' LEDs on the status panel of the 231HC will illuminate. After about 35 volts, the status panel LEDs should change to 'Amplifier Power', 'Amplifier Ready (green aspect) and 'Output Enabled'.

Please refer to the Copley Controls manual for the 231HC Amplifier for more information if needed.

4.3 - External Control

To use the external control option, set the 'Control Mode' switch on the rear panel to 'External'. This disconnects the internal DAC and connects the Analog Input terminal to the amplifier analog control input. One thing to note is that it is still possible to use the internal DaqPAD for monitoring the 231HC even when using an external analog control signal.

Connect an analog voltage source to the Analog Input terminal. This source should be capable of delivering voltages from -10V to +10V. The amplifier current output is proportional to the analog control input voltage.

Take care not to exceed an instantaneous dc power dissipation in the electromagnet in excess of 4,160W when using the SGA 160/31 power supply, or 9,280W when using the SGA 160/63 power supply. If this is exceeded, the amplifier may enter a mode that draws more power than the DC supply can provide and the DC power supply will shut down. When the DC supply voltage drops, the amplifier enters a 'DC Fault' mode and shuts down. Once shut down, the DC supply will recover, then the amplifier recovers, restarts and the cycle repeats. The only way to break the cycle is to reduce analog control signal to zero.

4.4 - Computer Control

To use the external control option, set the 'Control Mode' switch on the rear panel to 'Internal'. This connects the internal DAC and disconnects the Analog Input terminal to the amplifier analog control input.

Start up the computer software and ensure that everything configured correctly. Please refer to the software manual for more information.

4.4.1 - USB-6251 DAQ

The National Instruments USB-6251 DAQ together with GMW's Magnet Control software provides control and monitoring of the 231HC Bipolar Amplifier. If GMW's Magnet Control software is not used, it is still possible to computer control the 231HC Bipolar Amplifier by writing custom software to communicate with the USB-6251. The table below describes the channels used and their functions.

USB-6251 Connections			
Signal	**Type**	**Direction**	**6251 Terminal**
Current Control Output ±10V output proportional to ±70A current output	Analog	Output	AO-0
Current Control Common	Ground	Ground	AO-GND
Current Monitor ±1V / 10A	Analog	Input	AI-1
Current Monitor Common	Analog	Input	AI-9
Voltage Monitor ±1V / 20V	Analog	Input	AI-0
Voltage Monitor Common	Analog	Input	AI-8
Field Monitor +	Analog	Input	AI-2
Field Monitor -	Analog	Input	AI-10
Field Monitor Common	Ground	Ground	AI-GND
+5V (Amplifier Power) - Active high, the 231HC DC supply is providing sufficient voltage for operation	Digital	Input	P0.0
Normal - Active low, the 231HC is ready and will operate when not inhibited	Digital	Input	P0.1
Inhibit - Active low, the front panel inhibit switch is active	Digital	Input	P0.2
Module Fault - Active low, the 231HC has a fault in the MOSFET power output module	Digital	Input	P0.3
DC Fault - Active low, one or more DC voltages are outside operating limits	Digital	Input	P0.4
Over Current - Active low, the 231HC is disabled due to current over limits	Digital	Input	P0.5
Over Temperature - Active low, the 231HC is disabled due to an over temperature condition	Digital	Input	P0.6
231HC Digital Ground	Ground	Ground	DGND
Interlock Status -	Digital	Input	P0.7
Interlock Status Common	Ground	Ground	DGND

Section 5

MAINTENANCE

The 231HC Bipolar Amplifier should operate for many years without any trouble provided that the following basic maintenance points are observed. Always remember that the ac power should be disconnected before performing any maintenance procedure. The 231HC generates lethal voltages and must not be operated with damaged components, protective covers or cable insulation. For more information, please refer to Section 2, Warnings

1. Electrical Connections: Ensure that all electrical connections are clean and tight. Ensure that the insulation of all electrical cables is undamaged and repair or replace if necessary. All electrical termination covers must be in place and firmly secured.

2. Warning Labels: Ensure that all protective covers on the system and the magnet are in place. There are warning labels on all removable covers.

3. Cooling: Check that the fan screens are clean and free of blockage. Ensure that the fans are operating at full efficiency.

4. Cleaning: To clean wipe the case with a soft cloth with a mild detergent or plain water. Do not use any solvents as they may damage the finish.

Section 6

DRAWINGS

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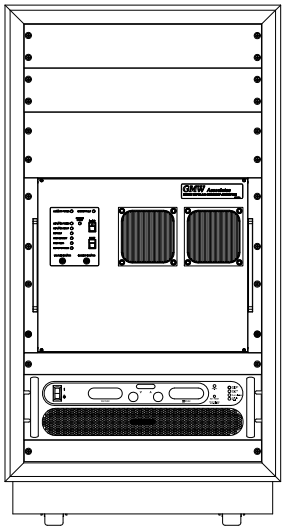
REVISIONS

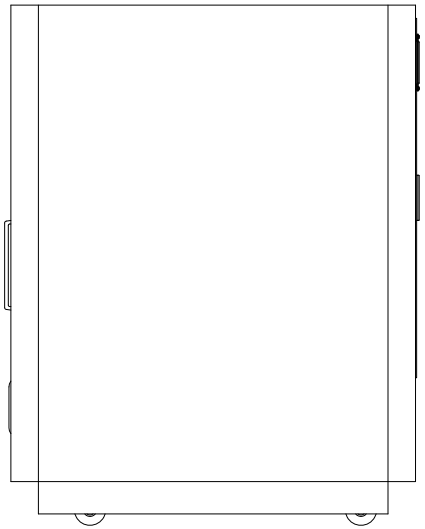
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		05 Oct, 2005	M. Duffy
B	CHANGE 231P to 231HC		9 Dec, 08	M. Duffy

SIDE VIEW

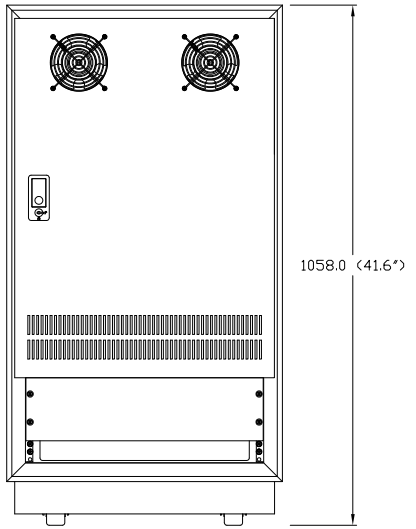
FRONT VIEW



SIDE VIEW



REAR VIEW



RACK MODEL: OPTIMA RC-351930

APPROX. WEIGHT: 135kg (300lbs) System with SGA 160/31 DC Power Supply
141kg (314lbs) System with SGA 160/63 DC Power Supply

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE

PARTS LIST

DRAWN M. Duffy	DATE 05 Oct, 2005	DO NOT SCALE FROM DRAWING
CHECK M. Duffy	DATE 05 Oct, 2005	DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)
ENGINEERING M. Duffy	DATE 05 Oct, 2005	

LINEAR	INCHES	mm
X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63	1.6

THIRD ANGLE PROJECTION

NEXT ASSY | SYSTEM

SOFTWARE AUTOCAD 2000

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
RACK ASSEMBLY
231HC AMPLIFIER

SIZE	DRAWING NO.	REV
A1	11907-0046-0	B

SCALE 1:5 | WT kg | SHEET 1 OF 1

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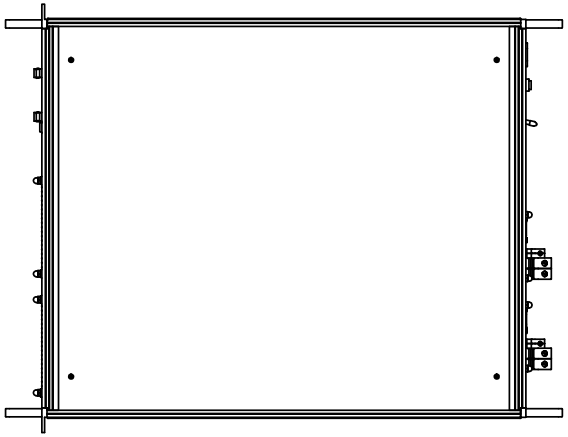
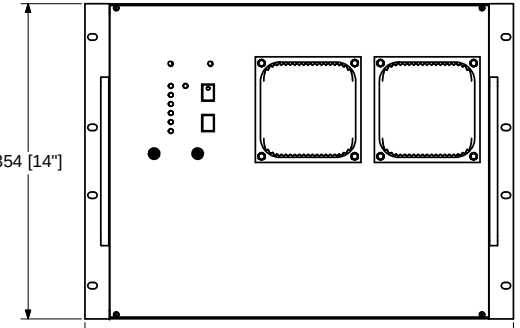
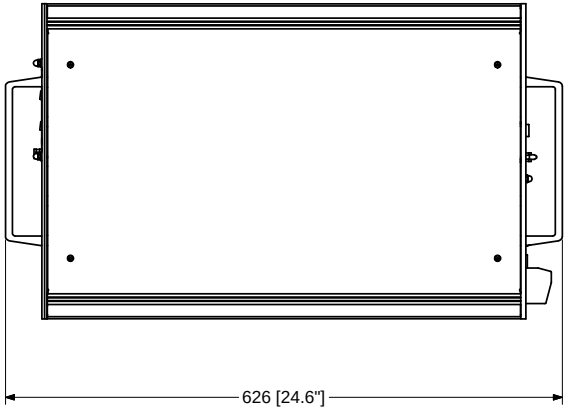
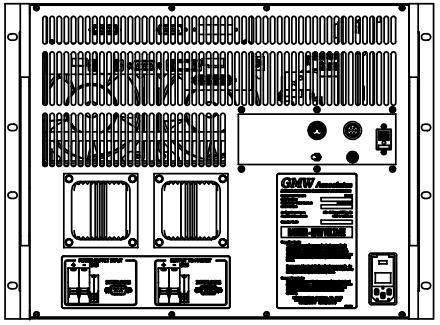
REVISION HISTORY

ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	Release	5 Sep, 06	Michael E. Duffy
	B	Add Power Requirements Block	20 Dec, 06	Michael E. Duffy
	C	Update Service Panel	22 May, 08	Michael E. Duffy









Power Requirements	
Auxiliary AC Power:	
Power One HAD12-0.4-A	120VAC @ 0.4A / 240VAC @ 0.2A, 50/60Hz
Power One HB12-1.7-A	120VAC @ 0.6A / 240VAC @ 0.3A, 50/60Hz
Cosel P15E-12	120VAC @ 0.3A / 240VAC @ 0.15A, 50/60Hz
Amplifier DC Power:	
Sorenson / Elgar SGA160/31C Output:	160V, 31A
AC Power Requirement:	187-242VAC, 3 Phase, 25A per phase 50/60Hz
Sorenson / Elgar SGA160/63C Output:	160V, 63A
AC Power Requirement:	187-242VAC, 3 Phase, 41A per phase 50/60Hz

DRAWN M. Duffy	Date 19 Dec, 06
CHECK M. Duffy	Date 19 Dec, 06
ENGINEERING M. Duffy	Date 19 Dec, 06

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES UNLESS OTHERWISE SPECIFIED

LINEAR	INCHES	mm
X.XXX	±.005	±0.03
X.XX	± .0	± 0.1
X.X	±.0	±0.3
X	.06	±1
DEG.	±.5	±0.5
FINISH	63	1.6

THIRD ANGLE PROJECTION

GMW Associates
955 Industrial Road, San Carlos, CA 94070
Tel: (650) 802-8292. Fax: (650) 802-8298

TITLE
231HC Bipolar Amplifier
General Assembly

SIZE	DRAWING No.	REV
A2	11907-0068-0	C

SCALE: NTS | WT: ~ kg | SHEET: 1 OF: 1

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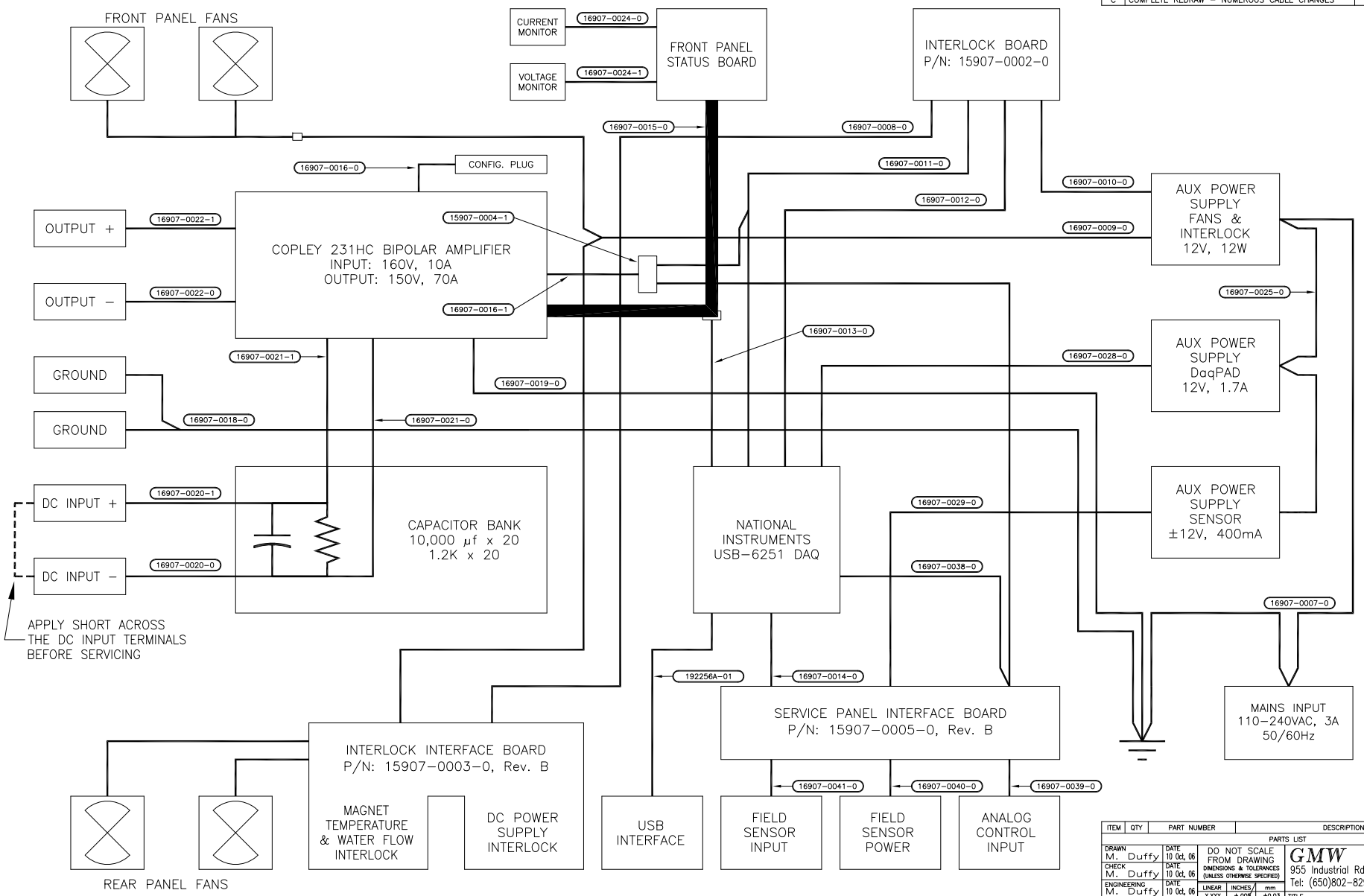
REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		10 Oct, 06	M. Duffy
B	CHANGE POWER SUPPLIES & WIRING		13 Dec, 06	M. Duffy
C	COMPLETE REDRAW – NUMEROUS CABLE CHANGES		23 May, 08	M. Duffy



ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE

PARTS LIST

DRAWN	M. Duffy	DATE	10 Oct, 06
CHECK	M. Duffy	DATE	10 Oct, 06
ENGINEERING	M. Duffy	DATE	10 Oct, 06
NEXT ASSY		SYSTEM	
SOFTWARE	AUTOCAD 2000		

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)

	LINEAR INCHES	LINEAR mm
X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63	1.6

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

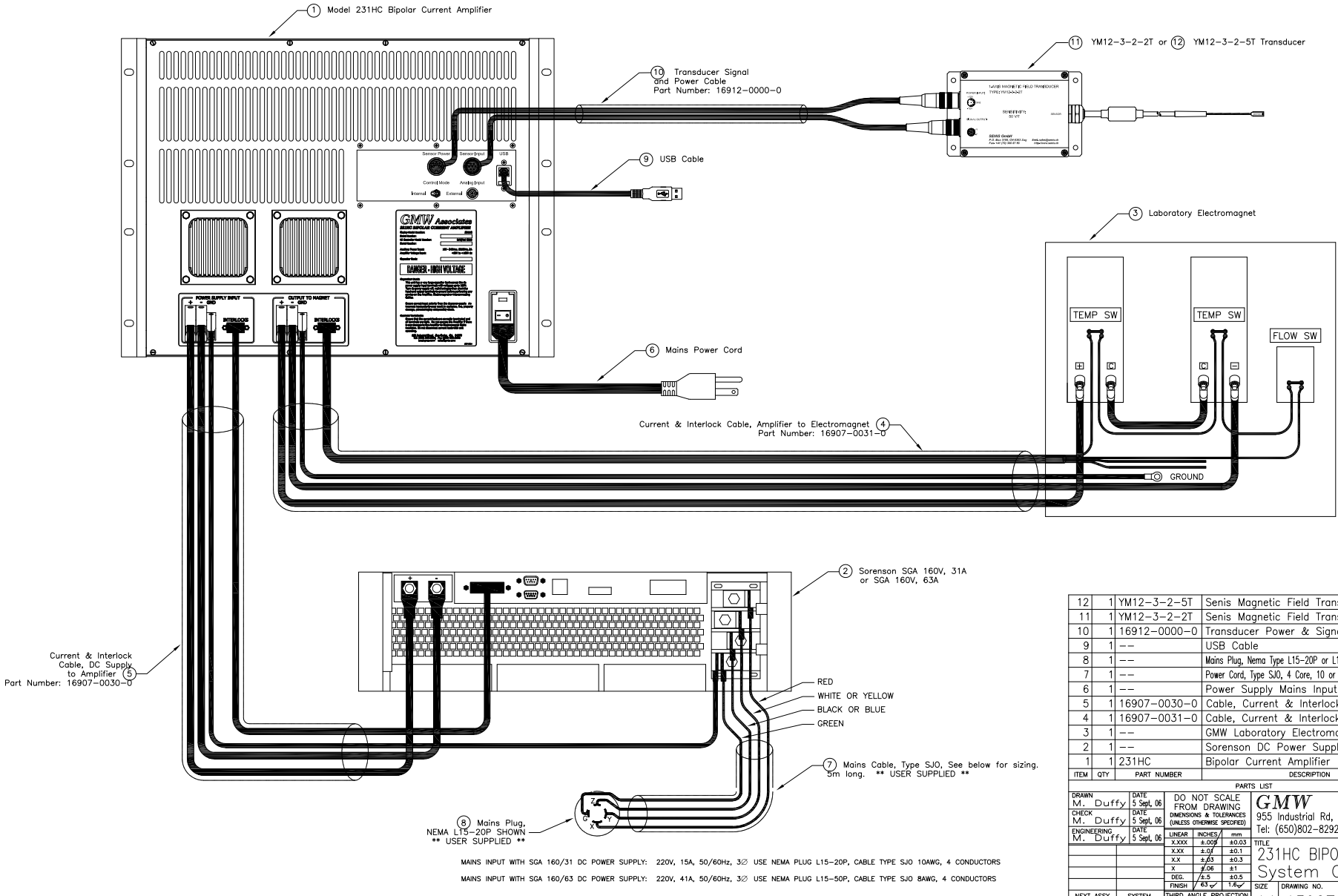
TITLE
231HC BIPOLAR AMPLIFIER
Block Diagram w/ DaqPAD

SIZE	DRAWING NO.	REV
A1	13907-0002-1	C

SCALE	WT kg	SHEET 1 OF 1

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		24 Aug, 06	M. Duffy
B	CHANGE POWER SUPPLIES & WIRING		13 Dec, 06	M. Duffy
C	CHANGE SERVICE PANEL AND YM12 CABLE		22 May, 08	M. Duffy


1 Model 231HC Bipolar Current Amplifier
10 Transducer Signal and Power Cable Part Number: 16912-0000-0
11 YM12-3-2-2T or 12 YM12-3-2-5T Transducer
9 USB Cable
3 Laboratory Electromagnet
TEMP SW
TEMP SW
FLOW SW
6 Mains Power Cord
Current & Interlock Cable, Amplifier to Electromagnet 4 Part Number: 16907-0031-0
GROUND
2 Sorenson SGA 160V, 31A or SGA 160V, 63A
Current & Interlock Cable, DC Supply to Amplifier 5 Part Number: 16907-0030-0
RED
WHITE OR YELLOW
BLACK OR BLUE
GREEN
7 Mains Cable, Type SJO, See below for sizing. 5m long. ** USER SUPPLIED **
8 Mains Plug, NEMA L15-20P SHOWN ** USER SUPPLIED **

MAINS INPUT WITH SGA 160/31 DC POWER SUPPLY: 220V, 15A, 50/60Hz, 3∅ USE NEMA PLUG L15-20P, CABLE TYPE SJO 10AWG, 4 CONDUCTORS

MAINS INPUT WITH SGA 160/63 DC POWER SUPPLY: 220V, 41A, 50/60Hz, 3∅ USE NEMA PLUG L15-50P, CABLE TYPE SJO 8AWG, 4 CONDUCTORS

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
12	1	YM12-3-2-5T	Senis Magnetic Field Transducer, 5T	
11	1	YM12-3-2-2T	Senis Magnetic Field Transducer, 2T	
10	1	16912-0000-0	Transducer Power & Signal Cable	
9	1	--	USB Cable	
8	1	--	Mains Plug, Nema Type L15-20P or L15-50P as appropriate	
7	1	--	Power Cord, Type SJO, 4 Core, 10 or 8 AWG as appropriate	
6	1	--	Power Supply Mains Input Cable	
5	1	16907-0030-0	Cable, Current & Interlock, Amp In	
4	1	16907-0031-0	Cable, Current & Interlock, Amp Out	
3	1	--	GMW Laboratory Electromagnet	
2	1	--	Sorenson DC Power Supply 160V, 31A	
1	1	231HC	Bipolar Current Amplifier	

PARTS LIST

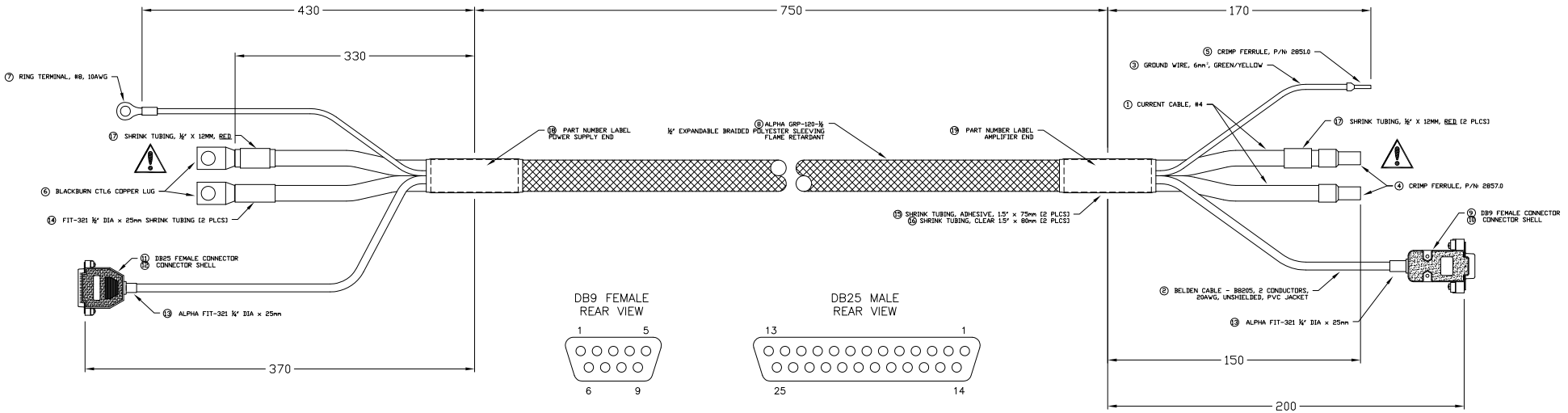
DRAWN M. Duffy	DATE 5 Sept, 06	DO NOT SCALE FROM DRAWING	GMW 955 Industrial Rd, San Carlos, CA 94070 Tel: (650)802-8292. Fax: (650)802-8298.
CHECK M. Duffy	DATE 5 Sept, 06	DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)	
ENGINEERING M. Duffy	DATE 5 Sept, 06	LINEAR: INCHES ±.005, mm ±0.03; X.XX ±.01, ±0.1; X.X ±.03, ±0.3; X ±.06, ±1; DEG. ±.5, ±0.5; FINISH 63 ✓, 1.6 ✓	TITLE 231HC BIPOLAR AMPLIFIER System Connections
NEXT ASSY	SYSTEM	THIRD ANGLE PROJECTION	SIZE A1 DRAWING NO. 13907-0003-0 REV C
SOFTWARE AUTOCAD 2000			SCALE WT kg SHEET 1 OF 1

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		14 SEPT, 06	M. Duffy

"A" END
CONNECT TO SGA DC POWER SUPPLY

"B" END
CONNECT TO 231 AMPLIFIER


430
330
750
170
370
150
200
⑦ RING TERMINAL, #8, 10AWG
⑰ SHRINK TUBING, ½" X 12MM, RED
⑥ BLACKBURN CTL6 COPPER LUG
⑭ FIT-321 ½" DIA x 25mm SHRINK TUBING (2 PLCS)
⑪ DB25 FEMALE CONNECTOR
⑮ CONNECTOR SHELL
⑬ ALPHA FIT-321 ¼" DIA x 25mm
⑱ PART NUMBER LABEL POWER SUPPLY END
⑧ ALPHA GRP-120-½ ½" EXPANDABLE BRAIDED POLYESTER SLEEVING FLAME RETARDANT
⑲ PART NUMBER LABEL AMPLIFIER END
⑮ SHRINK TUBING, ADHESIVE, 1.5" x 75mm (2 PLCS)
⑯ SHRINK TUBING, CLEAR 1.5" x 80mm (2 PLCS)
⑤ CRIMP FERRULE, P/N: 2851.0
③ GROUND WIRE, 6mm², GREEN/YELLOW
① CURRENT CABLE, #4
⑰ SHRINK TUBING, ½" X 12MM, RED (2 PLCS)
④ CRIMP FERRULE, P/N: 2857.0
⑨ DB9 FEMALE CONNECTOR
⑯ CONNECTOR SHELL
② BELDEN CABLE - B8205, 2 CONDUCTORS, 20AWG, UNSHIELDED, PVC JACKET
⑬ ALPHA FIT-321 ¼" DIA x 25mm

DB9 FEMALE
REAR VIEW

DB25 MALE
REAR VIEW

CUT LENGTHS:
- CURRENT CABLE – 1230mm
- GROUND – 1350mm
- INTERLOCK – 1320mm

SIGNAL	WIRE COLOUR	DB9 PIN	DB25 PIN
INTLK. COMMON	BLACK	1	2
INTLK. N.O.	RED	9	3

⚠ WARNING: THE RED (POSITIVE) TERMINATION OF THE CABLE MUST BE CONNECTED TO THE POSITIVE TERMINALS OF THE DC POWER SUPPLY AND THE 231HC AMPLIFIER. INCORRECT CONNECTION WILL DAMAGE THE CAPACITOR BANK RESULTING IN POSSIBLE FIRE OR EXPLOSION.

NOTE:
1. REFER TO DRAWING 169XX-0000-0 FOR BASIC CABLE ASSEMBLY
2. MAXIMUM CONTINUOUS CURRENT: 70 Amps
3. TOTAL CABLE RESISTANCE: 0.00042 Ohms
4. NOMINAL VOLTAGE DROP @ MAXIMUM CURRENT: 0.0299 Volts

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
19	1	10907-0059-1	LABEL, AMPLIFIER END	
18	1	10907-0059-0	LABEL, DC POWER SUPPLY END	
17	2	FIT-221-1/2-RED	SHRINK TUBING, RED, ½" X 12mm	
16	2	FIT-221-1-CLEAR	SHRINK TUBING, CLEAR, 1" X 80mm	
15	2	FIT-321-1	SHRINK TUBING, ADHESIVE WALL, 1" X 75mm	
14	1	FIT-321-1/2	SHRINK TUBING, ADHESIVE WALL, ½" X 25mm	
13	2	FIT-321-1/4	SHRINK TUBING, ADHESIVE WALL, ¼" X 25mm	
12	1	C88E321005	S-SUB 25 PIN CONNECTOR HOOD	
11	1	5-747913-2	D-SUB 25 PIN CONNECTOR, FEMALE, SOLDER CUP	
10	1	C88E301005	S-SUB 9 PIN CONNECTOR HOOD	
9	1	5-747905-2	D-SUB 9 PIN CONNECTOR, FEMALE, SOLDER CUP	
8	A/R	GRP-120-½	EXPANDABLE POLYESTER SLEEVING, FLAME RETARDANT	
7	1	35108	RING TERMINAL, #8, 12 – 10AWG	
6	2	CTL438	COPPER COMPRESSION LUG, #4 CABLE, ⅜" STUD	
5	1	2851.0	FERRULE, INSULATED, 10AWG	
4	2	2857.0	FERRULE, INSULATED, 4AWG	
3	A/R	86026030	GROUND WIRE, 6mm², GREEN/YELLOW	
2	A/R	B8205	CABLE, 2 CONDUCTORS, 20AWG, PVC JACKET	
1	A/R	A2004B-07	CABLE, COBRA X-FLEX, 4/0, 1,000V INSULATION	

PARTS LIST

DRAWN M. Duffy	DATE 14 SEPT, 06	DO NOT SCALE FROM DRAWING	GMW
CHECK M. Duffy	DATE 14 SEPT, 06	DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)	955 Industrial Rd, San Carlos, CA 94070
ENGINEERING M. Duffy	DATE 14 SEPT, 06		Tel: (650)802-8292. Fax: (650)802-8298.

LINEAR	INCHES	mm
X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63 ✓	1.6 ✓

NEXT ASSY	SYSTEM
SOFTWARE AUTOCAD 2000	THIRD ANGLE PROJECTION

TITLE: 231HC BIPOLAR AMPLIFIER DC SUPPLY TO AMPLIFIER CABLE

SIZE	DRAWING NO.	REV
A1	16907-0030-0	A

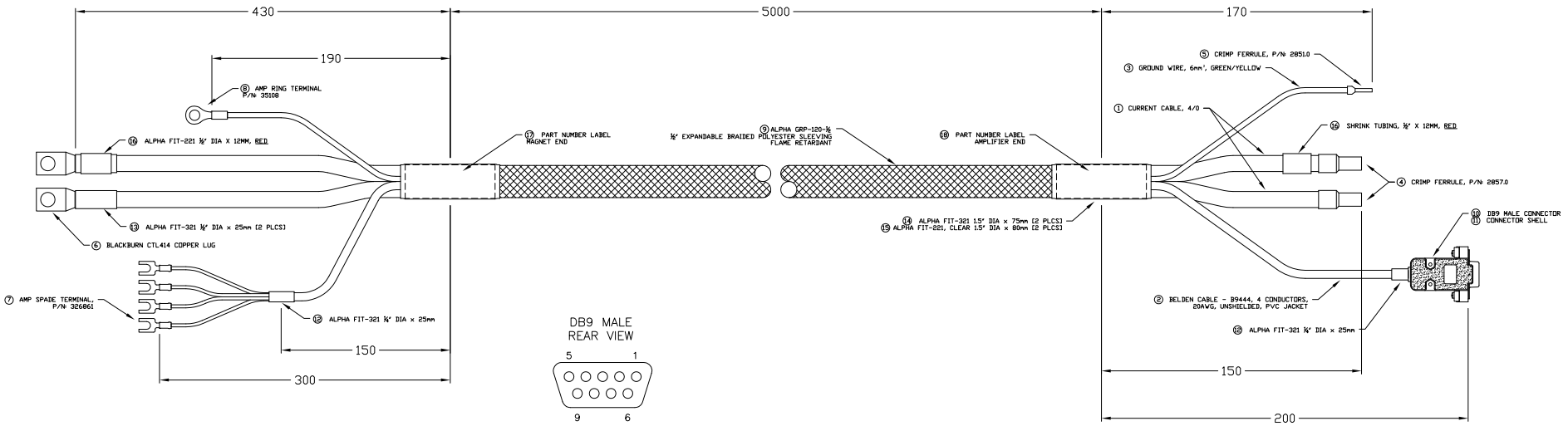
SCALE	WT kg	SHEET 1 OF 1

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		14 SEPT, 06	M. Duffy

"A" END
CONNECT TO ELECTROMAGNET

"B" END
CONNECT TO 231HC AMPLIFIER


430
5000
170
190
150
300
150
200
⑧ AMP RING TERMINAL P/N 35108
⑯ ALPHA FIT-221 ½" DIA X 12MM, RED
⑬ ALPHA FIT-321 ½" DIA x 25mm (2 PLCS)
⑥ BLACKBURN CTL414 COPPER LUG
⑦ AMP SPADE TERMINAL, P/N 326861
⑫ ALPHA FIT-321 ¼" DIA x 25mm
⑰ PART NUMBER LABEL MAGNET END
⑨ ALPHA GRP-120-½ ½" EXPANDABLE BRAIDED POLYESTER SLEEVING FLAME RETARDANT
⑱ PART NUMBER LABEL AMPLIFIER END
⑭ ALPHA FIT-321 1.5" DIA x 75mm (2 PLCS)
⑮ ALPHA FIT-221, CLEAR 1.5" DIA x 80mm (2 PLCS)
⑤ CRIMP FERRULE, P/N 2851.0
③ GROUND WIRE, 6mm², GREEN/YELLOW
① CURRENT CABLE, 4/0
⑯ SHRINK TUBING, ½" X 12MM, RED
④ CRIMP FERRULE, P/N 2857.0
⑩ DB9 MALE CONNECTOR
⑪ CONNECTOR SHELL
② BELDEN CABLE - B9444, 4 CONDUCTORS, 20AWG, UNSHIELDED, PVC JACKET
⑫ ALPHA FIT-321 ¼" DIA x 25mm

DB9 MALE
REAR VIEW

CUT LENGTHS:
- CURRENT CABLE – 5580mm
- GROUND – 5360mm
- INTERLOCK – 5500mm

SIGNAL	WIRE COLOUR	DB9 PIN
TEMP. INTLK. OUT	BLACK	1
TEMP. INTLK. RETN	RED	9
FLOW INTLK. OUT	GREEN	5
FLOW INTLK. RETN	WHITE	6

NOTE:
1. REFER TO DRAWING 169XX-0000-0 FOR BASIC CABLE ASSEMBLY
2. MAXIMUM CONTINUOUS CURRENT: 70 Amps
3. TOTAL CABLE RESISTANCE: 0.00194 Ohms
4. NOMINAL VOLTAGE DROP @ MAXIMUM CURRENT: 0.1358 Volts

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
18	1	10907-0059-1	LABEL, AMPLIFIER END	
17	1	10907-0059-0	LABEL, MAGNET END	
16	2	FIT-221-1/2-RED	SHRINK TUBING, RED, ½" X 12mm	
15	2	FIT-221-1-CLEAR	SHRINK TUBING, CLEAR, 1" X 80mm	
14	2	FIT-321-1	SHRINK TUBING, ADHESIVE WALL, 1" X 75mm	
13	1	FIT-321-1/2	SHRINK TUBING, ADHESIVE WALL, ½" X 25mm	
12	2	FIT-321-1/4	SHRINK TUBING, ADHESIVE WALL, ¼" X 25mm	
11	1	C88E301005	S-SUB 9 PIN CONNECTOR HOOD	
10	1	5-747904-2	D-SUB 9 PIN CONNECTOR, MALE, SOLDER CUP	
9	A/R	GRP-120-½	EXPANDABLE POLYESTER SLEEVING, FLAME RETARDANT	
8	1	35108	RING TERMINAL, #8, 12 – 10AWG	
7	4	326861	FORK TERMINAL, #6, 22 – 16AWG	
6	2	CTL414	COPPER COMPRESSION LUG, #4 CABLE, ¼" STUD	
5	1	2851.0	FERRULE, INSULATED, 10AWG	
4	2	2857.0	FERRULE, INSULATED, 4AWG	
3	A/R	86026030	GROUND WIRE, 6mm², GREEN/YELLOW	
2	A/R	B9444	CABLE, 4 CONDUCTORS, 20AWG, PVC JACKET	
1	A/R	A2004B-07	CABLE, COBRA X-FLEX, 4/0, 1,000V INSULATION	

PARTS LIST

DRAWN	M. Duffy	DATE 14 SEPT, 06
CHECK	M. Duffy	DATE 14 SEPT, 06
ENGINEERING	M. Duffy	DATE 14 SEPT, 06
NEXT ASSY	SYSTEM	
SOFTWARE	AUTOCAD 2000	

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)

LINEAR	INCHES	mm
X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63	1.6

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
231HC BIPOLAR AMPLIFIER
AMPLIFIER TO MAGNET CABLE

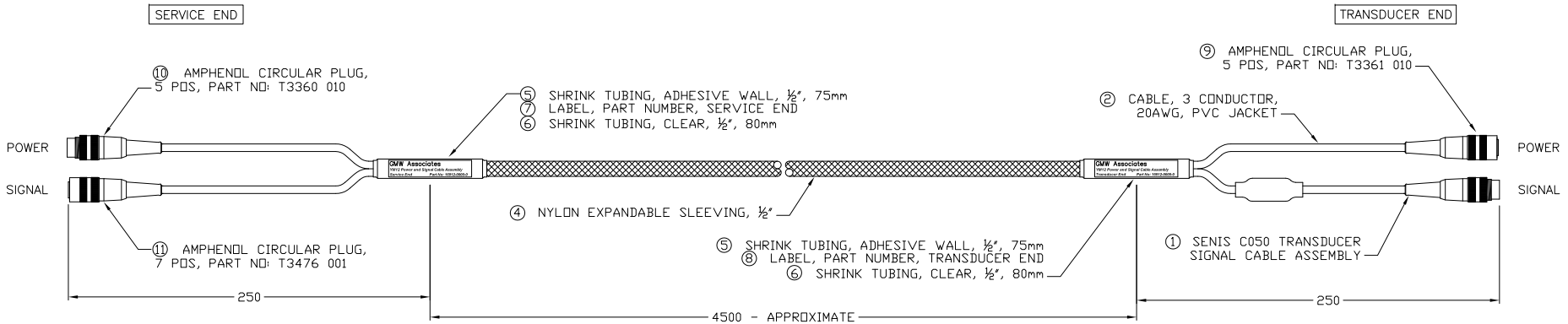
SIZE	DRAWING NO.	REV
A1	16907-0031-0	A

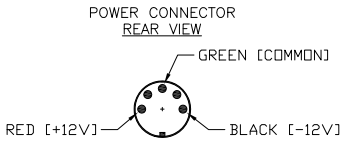
SCALE | WT kg | SHEET 1 OF 1

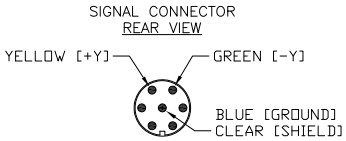
PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

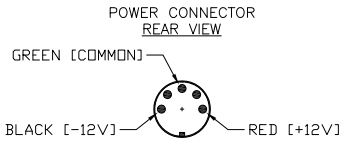
REVISIONS

REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		5 Aug, 08	M. Duffy
B	CORRECT POLARITY OF SIGNAL CONNECTOR		16 Dec, 08	M. Duffy


SERVICE END
TRANSDUCER END
⑩ AMPHENOL CIRCULAR PLUG, 5 POS, PART NO: T3360 010
⑤ SHRINK TUBING, ADHESIVE WALL, ½", 75mm
⑦ LABEL, PART NUMBER, SERVICE END
⑥ SHRINK TUBING, CLEAR, ½", 80mm
⑨ AMPHENOL CIRCULAR PLUG, 5 POS, PART NO: T3361 010
② CABLE, 3 CONDUCTOR, 20AWG, PVC JACKET
POWER
SIGNAL
GMW Associates
YM12 Power and Signal Cable Assembly
Service End Part No: 16912-0000-0
GMW Associates
YM12 Power and Signal Cable Assembly
Transducer End Part No: 16912-0000-0
④ NYLON EXPANDABLE SLEEVING, ½"
⑤ SHRINK TUBING, ADHESIVE WALL, ½", 75mm
⑧ LABEL, PART NUMBER, TRANSDUCER END
⑥ SHRINK TUBING, CLEAR, ½", 80mm
⑪ AMPHENOL CIRCULAR PLUG, 7 POS, PART NO: T3476 001
① SENIS C050 TRANSDUCER SIGNAL CABLE ASSEMBLY
250
4500 - APPROXIMATE
250







SERVICE END LABEL 2:1

GMW Associates
YM12 Power and Signal Cable Assembly
Service End Part No: 16912-0000-0

TRANSDUCER END LABEL 2:1

GMW Associates
YM12 Power and Signal Cable Assembly
Transducer End Part No: 16912-0000-0

12

60

NOTE:
1: REFER TO DRAWING NO: 169XX-0000-0; "BASIC ASSEMBLY OF CABLES FITTED WITH EXPANDABLE NYLON SLEEVING" FOR CABLE ASSEMBLY PROCEDURES.

2: POWER CABLE TYPE IS BELDEN 9444 – 4 CONDUCTORS; RED, BLACK, GREEN & WHITE. THE WHITE WIRE IS NOT USED AND SHOULD BECUT BACK UNDER THE SHEATH AT BOTH ENDS.

PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
11	1	T3476 001	AMPHENOL CIRCULAR CONNECTOR, 7 POS, FEMALE	
10	1	T3360 010	AMPHENOL CIRCULAR CONNECTOR, 5 POS, MALE	
9	1	T3361 010	AMPHENOL CIRCULAR CONNECTOR, 5 POS, FEMALE	
8	1		LABEL, PART NUMBER, TRANSDUCER END	
7	1		LABEL, PART NUMBER, SERVICE END	
6	2	FIT-221-1/2-CLEAR	SHRINK TUBING, CLEAR, 1/2" x 80mm	
5	2	FIT-321-1/2	SHRINK TUBING, ADHESIVE WALL, 1/2" x 75mm	
4	A/R		NYLON EXPANDABLE SLEEVING, 1/2"	
3	A/R		ELECTRICAL TAPE, 1/2" x 50mm, BLACK	
2	A/R	B9444	CABLE, 4 CONDUCTOR, 20AWG	
1	1	C050	SIGNAL CABLE ASSEMBLY – SENIS	

DRAWN M. Duffy DATE 5 Aug, 08
CHECK M. Duffy DATE 5 Aug, 08
ENGINEERING M. Duffy DATE 5 Aug, 08
NEXT ASSY SYSTEM
SOFTWARE AUTOCAD 2000

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)

	LINEAR INCHES	LINEAR mm
X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63	1.6

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
SENIS YM12 CABLE SIGNAL AND POWER

SIZE A1 | DRAWING NO. 16912-0000-0 | REV B
SCALE | WT kg | SHEET 1 OF 1

Section 7

PHOTOGRAPHS

231HC Front View

231HC Rear View

231HC & Sorenson SGA Power Supply in an Optima 19” Rack front view

Optima Rack rear view

Section 8

231HC with GMW ELECTROMAGNETS

8.1 Table - GMW Electromagnets and appropriate DC Power Supplies for use with the 231HC

GMW Electromagnet	Peak DC Power	Xantrex - Sorenson Power Supply
5403, 5403EG, 5403FC, 5403AC	70A, 33V, 2,500W	SGA 160/31, 160V, 31A, 4,960W
3472-50, 3472-70	70A, 50V, 3,500W	SGA 160/31, 160V, 31A, 4,960W
3473-50, 3473-70	70A, 59V, 4,100W	SGA 160/63, 160V, 63A, 10,080W
5451	70A, 25V, 1,800W	SGA160/31, 160V, 31A, 4,960W

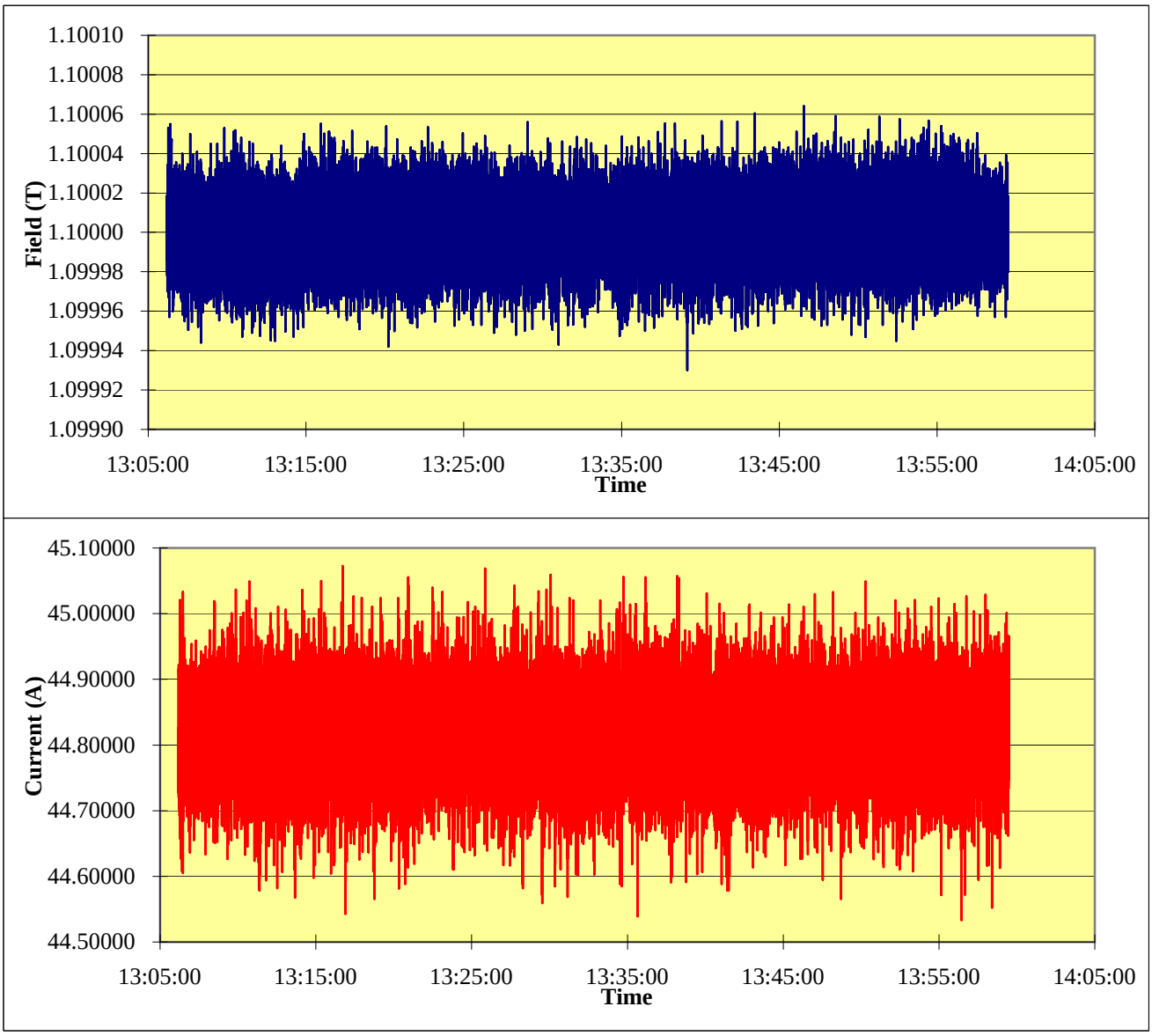
8.2 Performance Data

GMW Associates

Electromagnet Stability Plot

Model:	5403	Engr:	Y.Qin
Serial Number:	246	Date:	12/14/2006
Field Sencor:	Senis YM12-3-2-2T	Pole Gap:	30mm
Power supply:	231HC, Bipolar	Pole Face:	38mm

Note 1: 50Hz low pass software filter on field reading
Note 2: Field mode (closed loop control)
Note 3: Field measured at the center of gap.

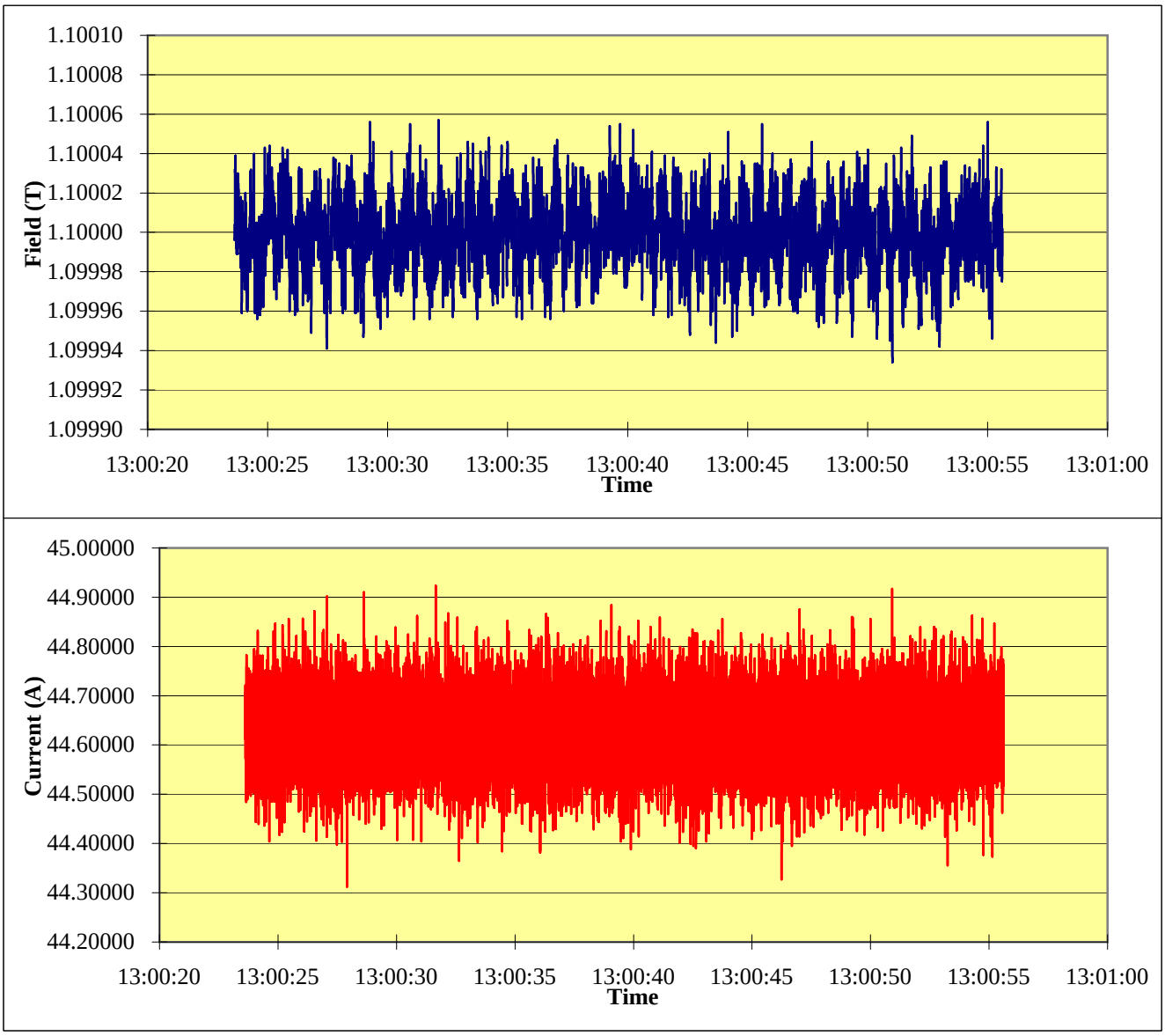


GMW Associates

Electromagnet Stability Plot

Model:	5403	Engr:	Y.Qin
Serial Number:	246	Date:	12/14/2006
Field Sencor:	Senis YM12-3-2-2T	Pole Gap:	30mm
Power supply:	231HC, Bipolar	Pole Face:	38mm

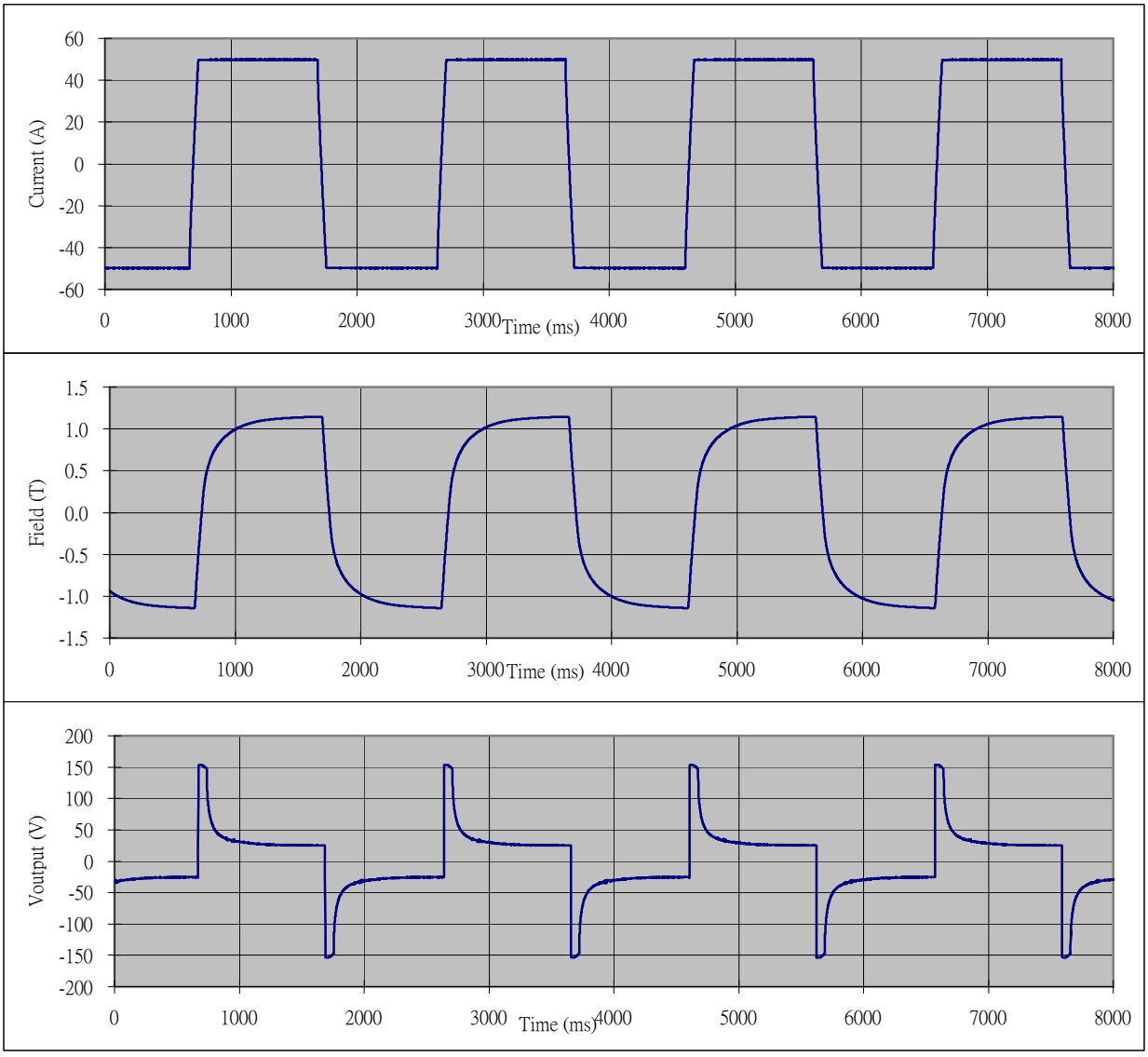
Note 1: 50Hz low pass software filter on field reading
Note 2: Field mode (closed loop control)
Note 3: Field measured at the center of gap.



GMW Associates

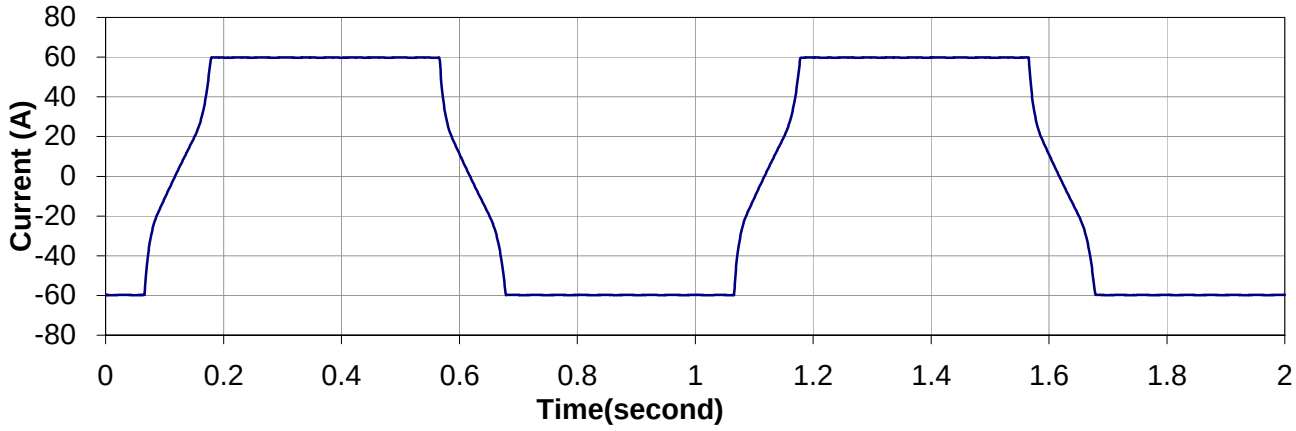
Electromagnet waveform

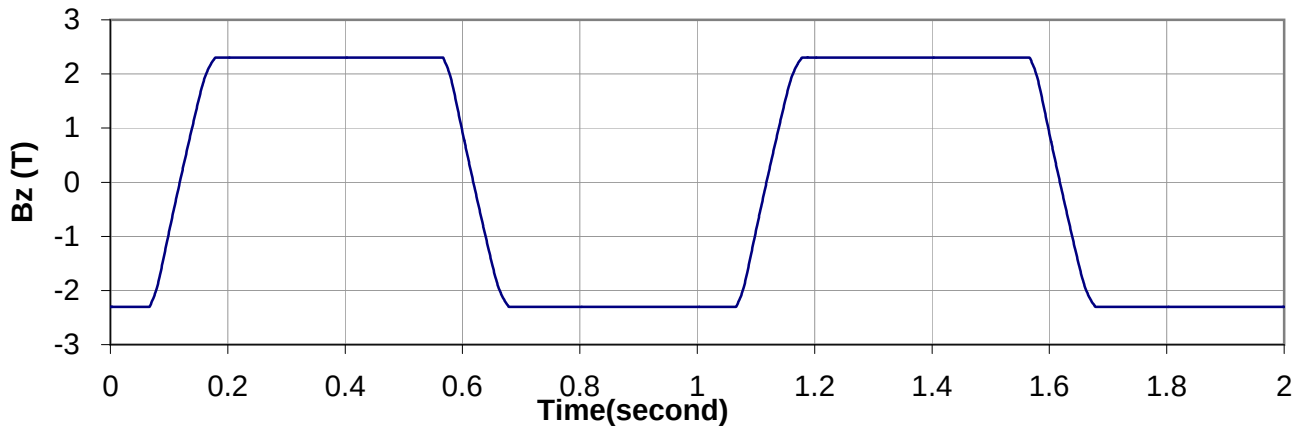
Model:	5403	Engr:	Y. Qin
Serial No:	246	Date:	12/20/2006
Note:	50A, 0.5Hz, square wave		
Note:	Current reading: 231P current readback+NI USB-6251		
	Field reading: Senis YM12-3-2-2T+NI USB-6251		
Power supply:	231HC		
Pole Gap:	30mm		
Pole Face:	38mm		
Position:	X=0, Y=0, Z=0		

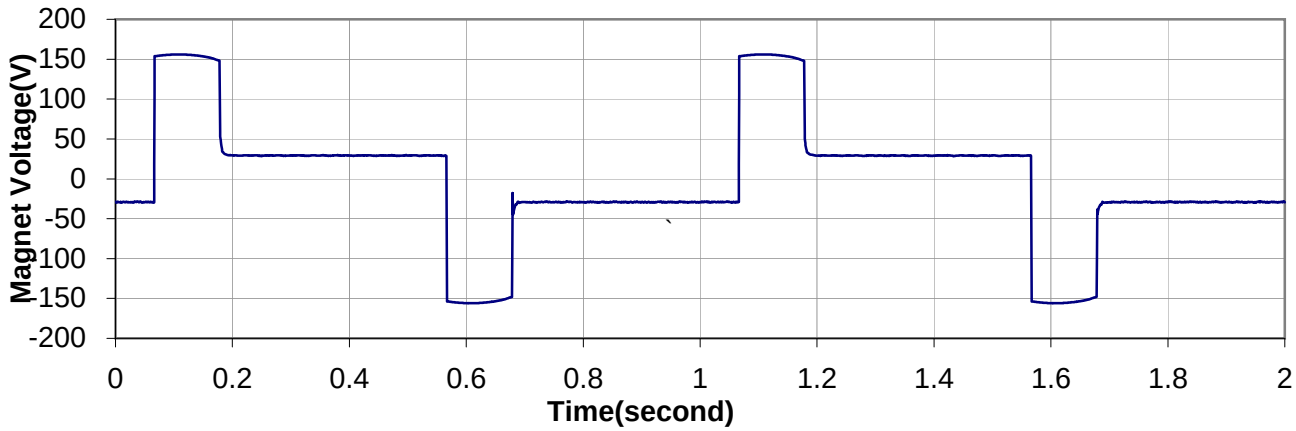


GMW ASSOCIATES
Electromagnet: Typical Waveform

Model:	5403AC	Engr:	Y.Q.
Serial No:	1	Date:	1/26/2007
Pole Face:	10mm	Page:	1 of 1
Pole gap:	10mm		
Power Supply:	231HC		
PS SN:	2606FD05		
Position:	X=Y=Z=0mm		
Current:	60A peak to peak		
Waveform:	1Hz, square		



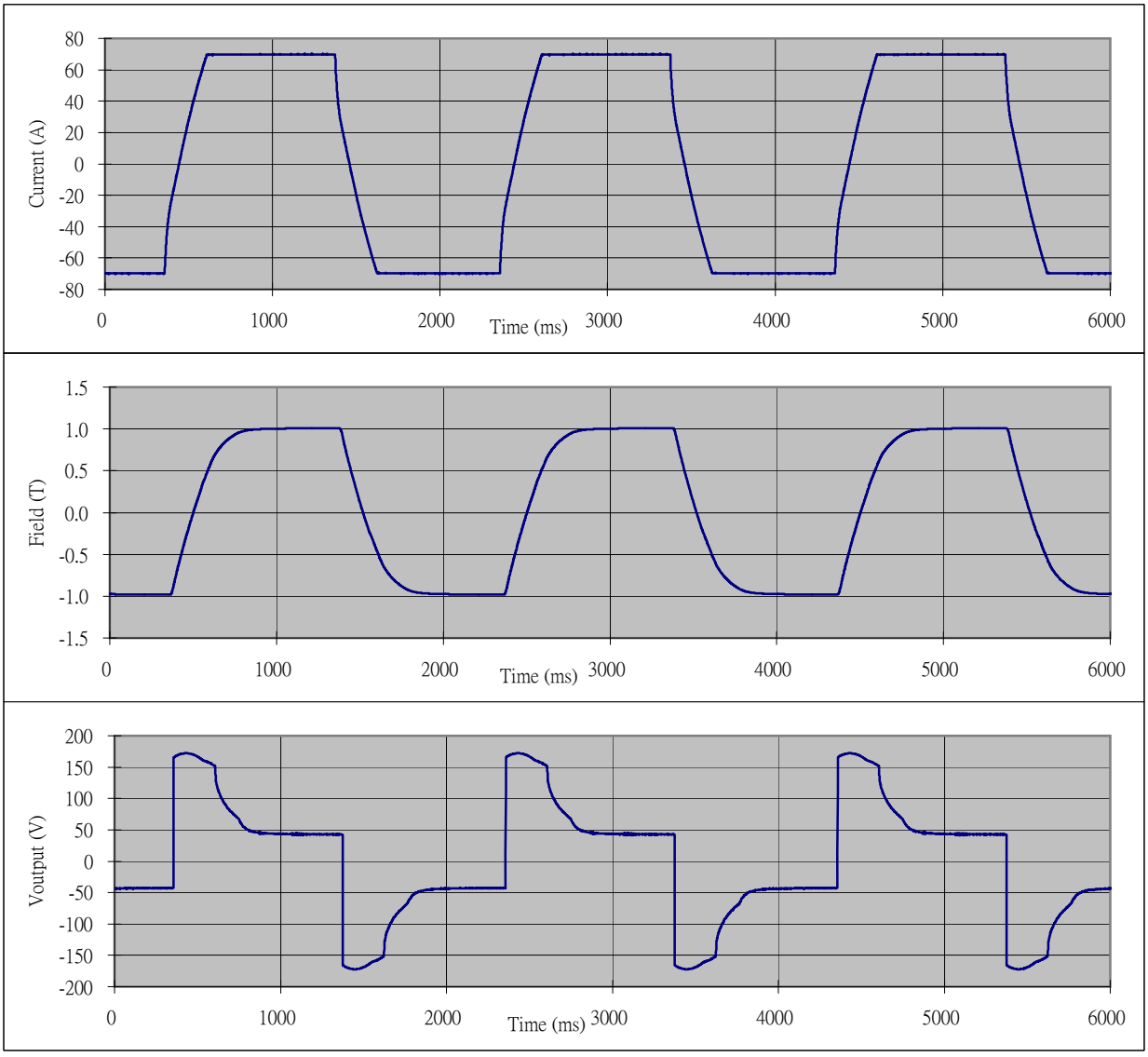




GMW Associates

Electromagnet waveform

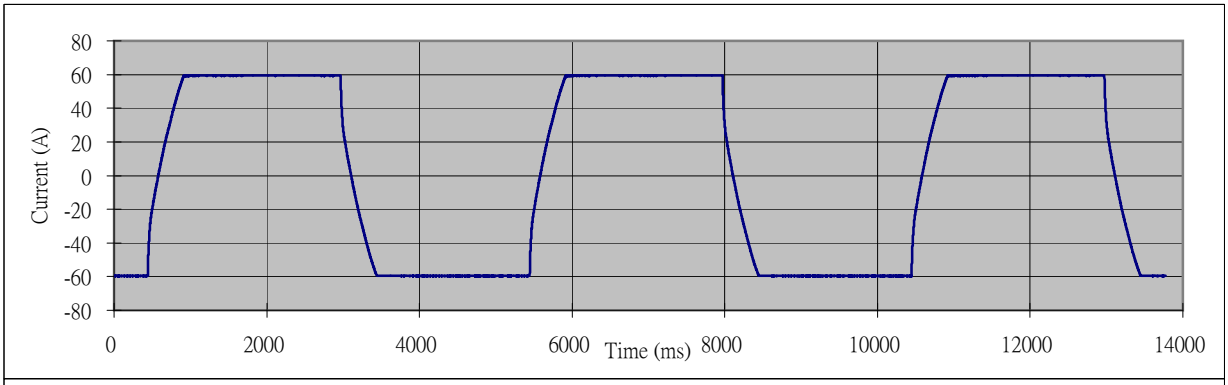
Model:	3472-70	Engr:	Y. Qin
Serial No:		Date:	12/18/2006
Note:	70A, 0.5Hz, square wave		
Note:	Current reading: 231P current readback+DAQpad6015		
	Field reading: Senis YM12-3-5-5T+DAQPad6015		
Power supply:	231HC		
Pole Gap:	50mm		
Pole Face:	100mm		
Position:	X=0, Y=0, Z=0		

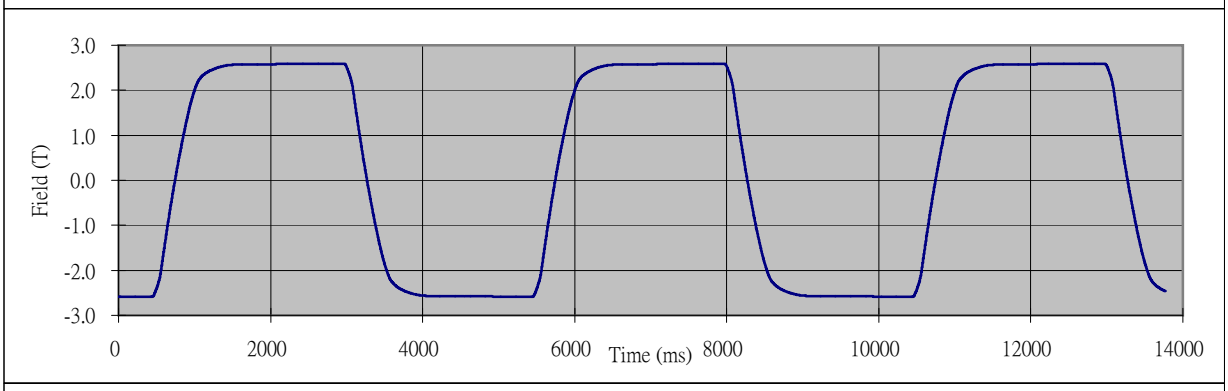


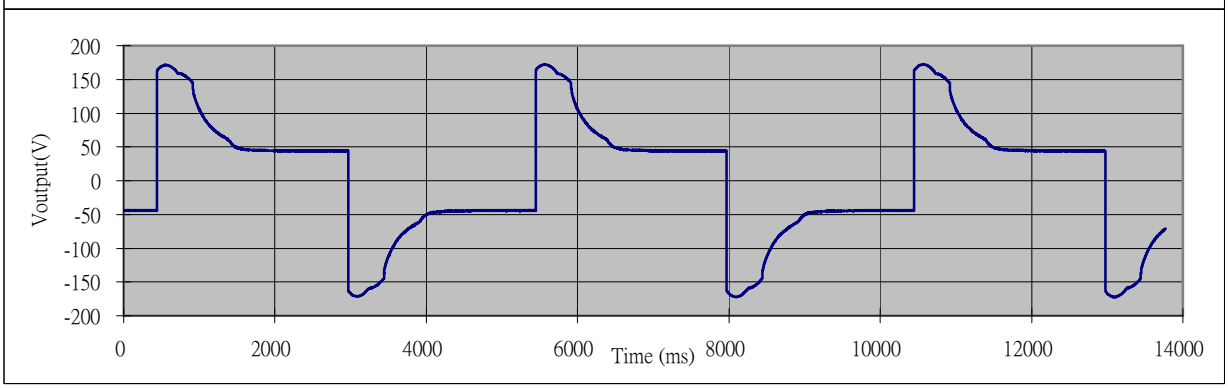
GMW Associates

Electromagnet waveform

Model:	3473-70	Engr:	Y. Qin
Serial No:	116	Date:	10/19/2006
Note:	60A, 0.2Hz, square wave		
Note:	Current reading: 231P current readback+DAQpad6015		
	Field reading: Senis YM12-3-5-5T+DAQPad6015		
Power supply:	231HC		
Pole Gap:	10mm		
Pole Face:	75mm		
Position:	X=0, Y=0, Z=0		





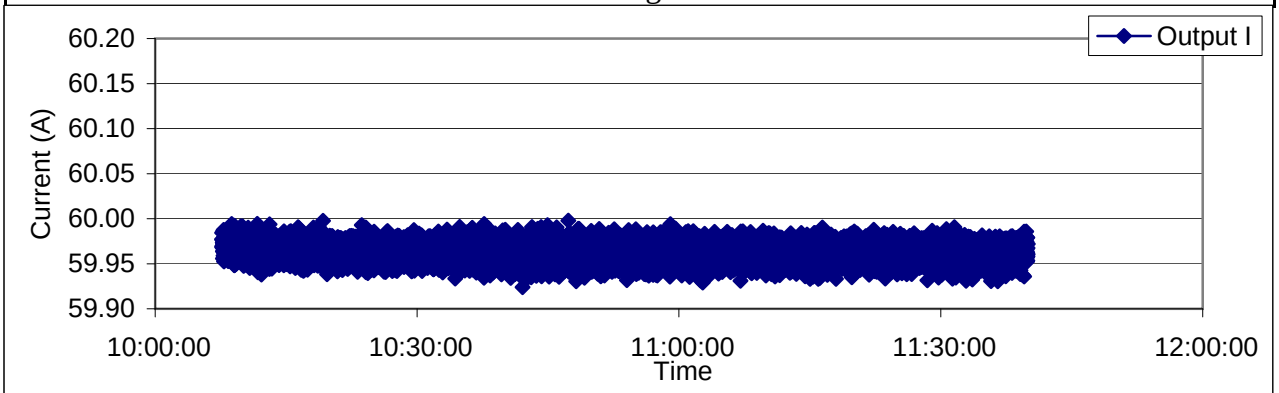


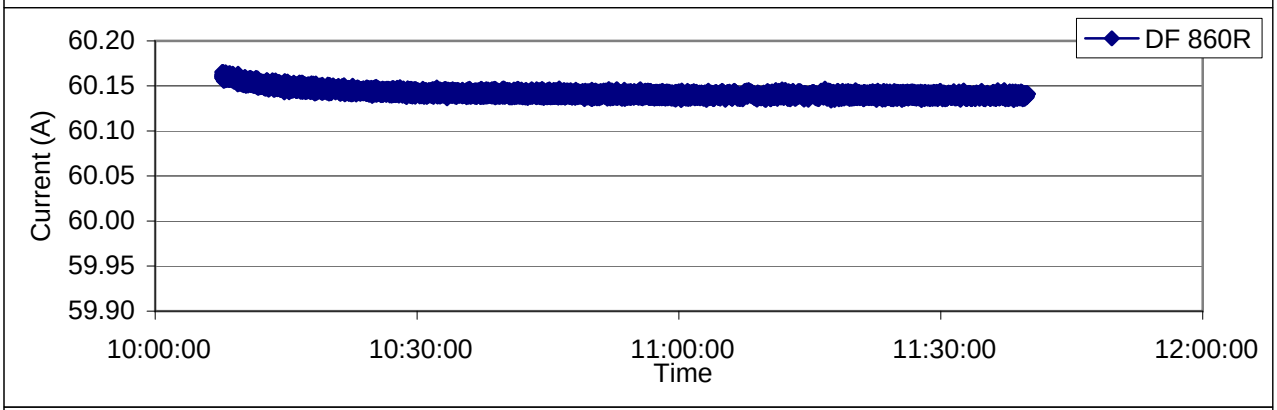
3473 75mm pole 10mm gap 0.2Hz square 60A.xls

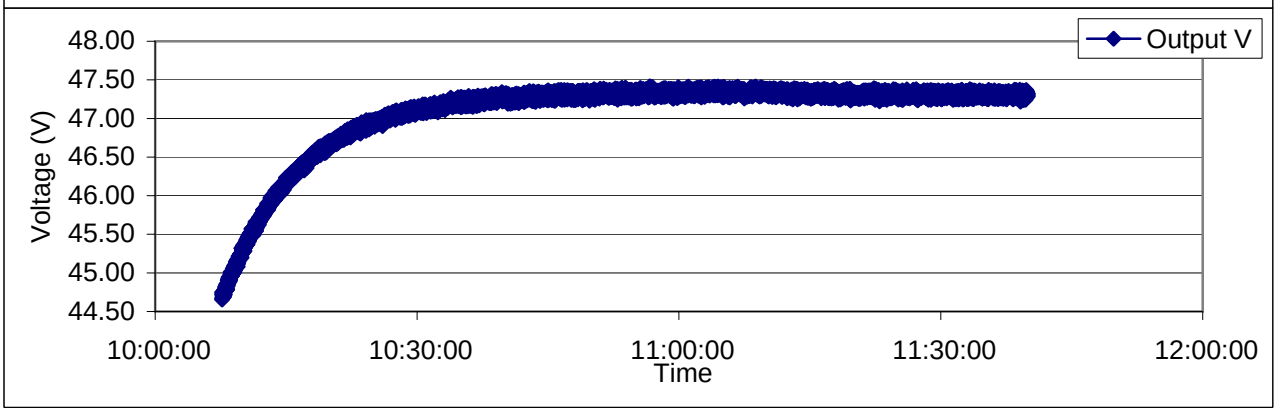
GMW Associates

Electromagnet Stability Plot

Model:	3473-70	Engr:	Y.Qin
Serial Number:	246	Date:	10/17/2008
Field Sencor:	No field sensor		
Power supply:	231HC, Bipolar, SN:134A7CE		
Note 1:	Cold start power supply, controlled with int DAQPad		
Note 2:	100Hz low pass software filter on reading, all reading using internal DAQPad		
Note 3:	Output I and Output V read from amplifier monitor		
Note 4:	Reference current measured using DF860R.		







GMW Associates
Electromagnet Stability Plot

Model:	3473-70	Engr:	Y.Qin
Serial Number	246	Date:	10/17/2008

Field Sencor: No field sensor
Power supply: 231HC, Bipolar, SN:134A7CE
Note 1: Cold start power supply, controlled with ext power supply, HP E3620A.
Note 2: 100Hz low pass software filter on reading, all reading using internal DAQPad
Note 3: Output I and Output V read from amplifier monitor
Note 4: Reference current measured using DF860R. Ip is program voltage